BERKELEY LAB

WHAT IS A GEOSCIENTIST?

Geoscientists study the Earth's resources and environment. They work to understand natural processes on Earth and other planets. Investigating the Earth, its soils, oceans, and atmosphere, forecasting the weather; developing land-use plans; exploring other planets and the solar system; determining environmental impacts; and finding new sources of useful Earth minerals are just a few of the ways geoscientists contribute to our understanding of Earth processes and history.

GEOSCIENCES CAREERS

WHAT DO GEOSCIENTISTS DO?

Geoscientists gather and interpret data about the Earth and other planets. They use their knowledge to increase our understanding of Earth processes and resources to improve the quality of human life. Their work and career paths vary widely because the geosciences are broad and diverse. The following list gives a glimpse of what geoscientists do in these disciplines and a variety of subdisciplines.

ATMOSPHERIC SCIENTISTS study weather processes; the global dynamics of climate; solar radiation and it effects; and the role of atmosphic chemistry in ozone depletion; climate change, and pollution.

ENVIRONMENTAL GEOLOGISTS study the interaction between the geosphere, hydrosphere, atmosphere, biosphere, and human activities. They work to solve problems associated with pollution, waste management, urbanization, and natural hazards, such as flooding and erosion.

GEOCHEMISTS use physical and inorganic chemistry to investigate the nature and distribution of major and trace elements in ground water, and Earth materials; they use organic chemistry study the composition of fossil fuel (coal, oil, and gas) deposits.

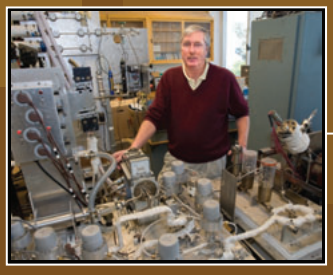
GEOPHYSICISTS apply the principles of physics to studies of the Earth's interior and investigate Earth's magnetic, electric, and gravitational fields.

HYDROLOGISTS are concerned with water from the moment of precipitation until it evaporates into the atmosphere or is discharged into the ocean; for example they study river systems to predict the impacts of flooding.

PALEONTOLOGISTS study fossils to understand past life forms and their changes through time and to reconstruct past environments.

PETROLEUM GEOLOGISTS are involved in exploration for and production of oil and natural-gas resources.

STRUCTURAL GEOLOGISTS analyze rocks by studying deformation, fracturing and folding of the Earth's crust.



SEISMOLOGISTS study earthquakes and analyze the behavior of earthquake waves to interpret the structure of the Earth.

JOB OUTLOOK

The employment outlook in the geosciences – as in any profession – varies with the economic climate of the country. The long-range outlook is good at this time. Dwindling energy, mineral, and water resources along with increasing concerns about the environment and natural hazards present new challenges in geosciences.

This information courtesy of the American Geological Institutes "Careers in the Geosciences" brochure.
For additional information visit their website at www.agiweb.org/career

BERKELEY LAB

ENHANCING ENERGY RESOURCES

ESD scientists are working with the geothermal, oil, and gas industries to develop innovative methods to increase production from subsurface energy resources.

UNDERSTANDING CLIMATE AND CARBON

ESD scientists are building the foundation for climate change prediction, impact assessment, and mitigation. We also discover insights into the biogeochemical cycles (terrestrial, oceanic, and atmospheric) that are critical to stewardship of water and energy resources, and insure the efficacy and safety of geologic CO_2 sequestration.

EARTH SCIENCES DIVISION

Securing our energy future in an environmentally responsible way, the Earth Sciences Division (ESD) brings together climate scientists, geochemists, geophysicists, hydrogeologists, microbiologists, computer scientists, and engineers, blending fundamental, applied, and theoretical research to tackle some of the planet's most pressing issues, related to:

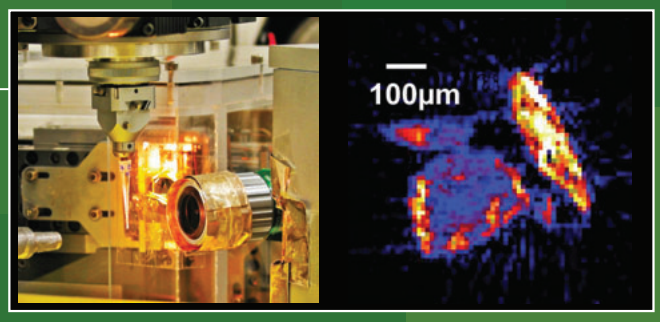
- Improved oil recovery
- Energy resources
- Climate change
- CO_2 sequestration
- Environmental remediation
- Nuclear energy and geological disposal

IMPROVING THE ENVIRONMENT

ESD scientists conduct advanced multidisciplinary research—using theoretical, numerical, and experimental approaches that range from the molecular to the field scale—to provide the scientific foundation needed for environmental remediation and water resources management.

EXPLORING EARTH'S SUBSURFACE

We are the world leader in characterizing and modeling both unsaturated zone fluid flow and transport, and thermally and chemically driven coupled processes. The key driver is to improve the scientific foundation of hydrological, thermal, geochemical, and geochemical processes and their interactions relevant to the long-term containment of nuclear waste.



UNDERSTANDING EARTH PROCESSES

ESD scientists use innovative techniques and resources to investigate the earth's complex coupled processes, at a variety of scales to better understand the processes that shape and control the planet, utilizing unique facilities such as the Advanced Light Source, the National Center for Electron Microscopy, the National Energy Research Scientific Computing Center, and the Molecular Foundry.

Explaining Hawaii Volcanoes

Scientists around the world, including ESD's Director Don DePaolo, have long wondered about the source of the lava erupting out of Hawaii's volcanoes. Does the lava originate from the uppermost part of the Earth's mantle, below its crust? Or is the ultimate source actually at the bottom of the mantle or even within the Earth's core? In a recent PBS film (Hawaii: Roots of Fire), these scientists recently tackled this question by pursuing new lines of evidence, produced by drilling into Mauna Kea, the Big Island's tallest volcano. They used the isotopic evidence within Mauna Kea to conclude that the lava originated from the Earth's core, creating a picture of Earth processes never before possible.

Find out more

bit.ly/p9DetW

Predicting Future Climates

Climate change refers to the change in climate patterns, known (through climate models) for up to hundreds of thousands of years back in time. Scientists are confident that climate is changing due to human activity over the last 200 years. This activity releases "greenhouse gases," mainly carbon in the form of carbon dioxide and methane, which causes the planet's overall temperature to rise. Within ESD, Margaret Torn and Bill Collins develop models that enable them to predict climate change, using what they learn throughout the globe about the complex processes shaping the planet, to help with understanding the impact of climate change and what actions can be taken in response to it.

Find out more

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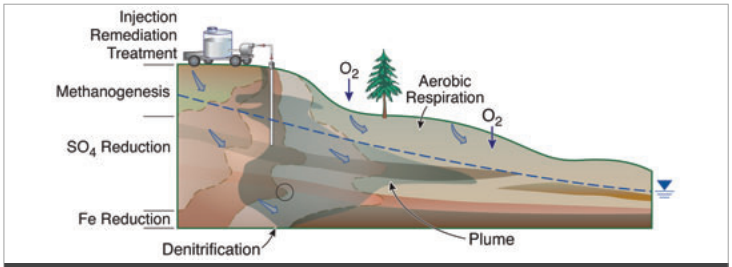

Is Remediation Working?

Production and testing of nuclear weapons in the U.S. has created extensive contamination, especially at so-called superfund sites. DOE has responded by taking on the responsibility to locate and clean up these sites. But it is often difficult to assess the response of these sites to remediation attempts using conventional methods, because of the complexity of the processes involved. An ESD team led by Susan Hubbard has been using time-lapse geophysical techniques to remotely monitor remediation treatments, with a recent focus on the use of the spectral induced polarization (SIP) method. This method measures the electrical resistivity and phase shift between an induced electrical current and recorded voltage to track and measure remediation-induced biogeochemical transformations.

Find out more

bit.ly/qFrmVH

Eating Oil Spills

Terry Hazen and a team of scientists from LBNL used the infrared imaging technology developed at the Lab's Advanced Light Source to measure how bacteria more than 1,000 meters below the ocean surface feasted on microscopic oil droplets like those shown here after the 2010 Deep Water Horizon oil spill in the Gulf of Mexico. These bacteria have had millennia to practice their art, since oil frequently leaks from natural seeps in the area. They have also evolved to tolerate chilly temperatures, for the depths where the plume exists are at a frosty 5° C. These microscopic cleaners could play a big role in deciding the ultimate fate of this oil spill.

Find out more

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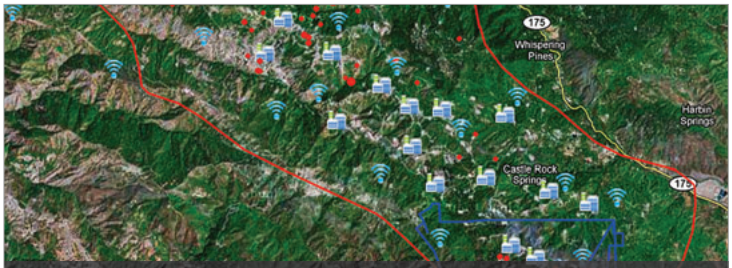

Enhancing Energy Recovery

Hydrogeologists have for decades been looking at ways of accessing difficult-to-get-at sources of energy. They've also been concerned, more recently, with looking for underground sites for sequestering large amounts of carbon dioxide. ESD's Ernie Majer and others are exploring ways to increase the productivity and effectiveness of such sites, while simultaneously ensuring public safety. Both energy recovery and geologic carbon sequestration efforts risk creating induced seismicity—small earthquakes created by high-rate, high-volume fluid injection or fluid withdrawal. As part of their work, Majer and his team have created a website to inform the public about safety measures related to induced seismicity. Use the "Find Out More" section to access the website.

Find out more

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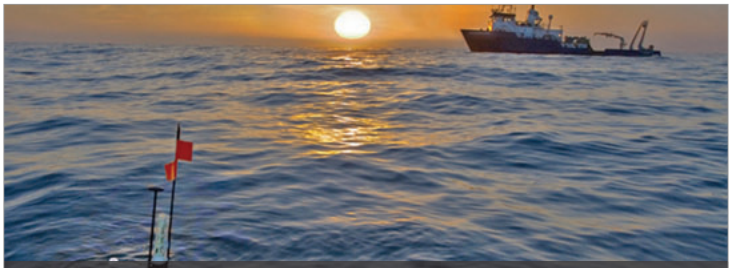

Deep Sea Discoveries

To understand the global carbon cycle, the Carbon Explorer, principally developed by Jim Bishop of the Berkeley Lab's Earth Sciences Division, descends and rises within the ocean on schedules that can be programmed and reprogrammed by satellite. With its system of carbon sensors, advanced communications devices, and remote operating capacity, the Carbon Explorer enables, for the first time, the continuous tracking of the biological processes of the carbon cycle in the ocean. Carbon Explorers were the first instruments to observe natural fertilization of a plankton bloom in the North Pacific by iron-rich, wind-blown dust from a storm in Central Asia. The Carbon Explorer was a 2006 winner of the R&D 100 Award.*

Find out more

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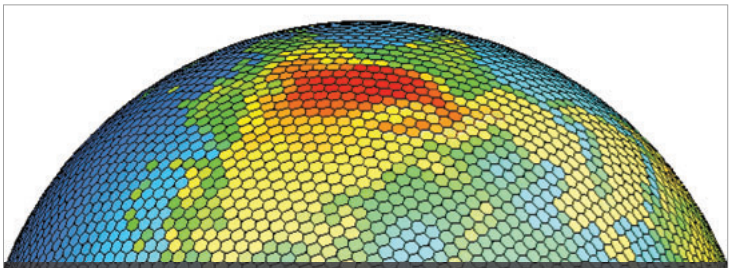

Supercomputers Unravel Clouds

Clouds stabilize the climate. They reflect sunlight, so they act like a sun shield. But they also trap heat from the Earth. The question arises, what happens if climate change makes the cloud cover decrease or increase? How clouds will be affected by climate change has become a critical question for climate modelers like ESD's William Collins. They are working to develop supercomputers to predict how clouds might be affected by sudden climate change, which will in turn lead to a better idea of changes in rainfall—critical information for our water supply, our forests, and our crops.

Find out more

bit.ly/qGKuMT

Capturing Unexploded Ordnance

Developed by Erika Gasperikova and other scientists within ESD, the Berkeley Lab Unexploded Ordnance Detector, a multisensor electromagnetic system that differentiates explosives from harmless metal, is the fastest, most accurate technology for detecting unexploded ordnance (UXO). It is applicable both in the U.S., where it can be used to remediate millions of acres of land mined with UXO; and worldwide, where buried explosives threaten people's safety. This UXO detector was a 2007 winner of the R&D 100 Award.*

Find out more

bit.ly/pC5Kbq

Finding the Perfect Microbial Match

Greengenes, a database developed by ESD's scientific team led by Todd DeSantis and Gary Andersen, aids researchers by compiling genes based on their 16S rRNA signature. Researchers from around the world can access the database online and enter 16S rRNA sequences extracted from samples of soil, water, and even animal tissue. A match with a sequence in Greengenes is a giveaway that a specific microbe is in the sample. If there's not a match, perhaps a new species has been discovered. Greengenes, which in March 2011 accepted and compiled its one-millionth high-quality DNA sequence, has been applied to many different scientific investigations in the fields of medicine, biofuels, and environmental cleanup.

Find out more

bit.ly/ohbn4s

PhyloChip Finds What You Can't See

The Berkeley Lab PhyloChip, developed by scientists led by ESD's Gary Andersen, is a DNA detector chip (microarray) that quickly, comprehensively, and accurately identifies bacterial species within samples from any environmental source, without any culturing required. Its contributions to public health, medical diagnostics, and environmental cleanup projects have already paid large dividends. The PhyloChip was voted the top advance in environmental technology (and third overall advance) in the world by the Wall Street Journal in 2008. The PhyloChip was also a winner of the R&D 100 Award in 2008.*

Find out more

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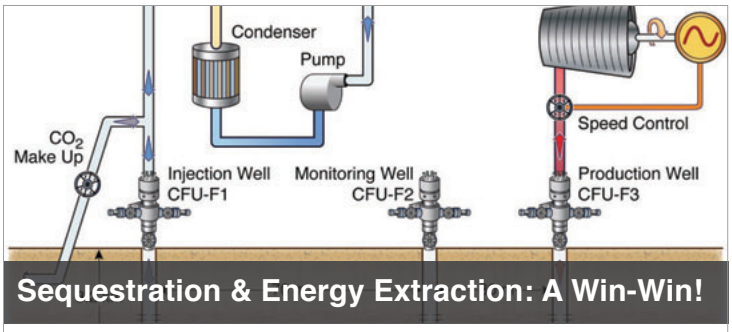

Sequestration & Energy Extraction: A Win-Win!

Carbon capture and storage (CCS)—capturing the CO_2 generated from burning fossil fuels and storing it underground—has recently been proposed as a way of mitigating climate change. Recent studies have shown the potential for combining CCS with geothermal energy extraction, using supercritical CO_2 ($ScCO_2$) as the fluid performing the extraction and producing electricity as a byproduct. ESD's Barry Freifeld is pursuing this "win-win" strategy—using CO_2 sequestration to simultaneously produce geothermal energy—in an important upcoming project. His international team is developing new ways to produce electricity from superheated and pressurized carbon dioxide in geothermal formations. Their particular project involves creation of new machinery to extract energy from CO_2 in deep sedimentary formations.

Find out more

bit.ly/nIfNaD

Hunting Down Hydrocarbons

The EMGeo ElectroMagnetic Geological Mapper, developed by ESD's Gregory Newman and Michael Commer, overcomes the technological problems involved in discriminating offshore hydrocarbon reservoirs by exploiting 21st century computing power—massively parallel computing resources—and combining that power with advanced electromagnetic measurement techniques. It thereby provides a unique imaging capability for detecting hydrocarbon deposits, finding sources of geothermal energy, and conducting environmental remediation. EMGeo was a 2009 winner of the R&D 100 Award.*

Find out more

bit.ly/pS5rHJ

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* Established by the editors of R&D Magazine, an R&D 100 Award is a mark of excellence known to industry,government, and academia as proof that the product is one of the most innovative of the year.